

Intramedullary Interlocking Nailing Versus Plating in distal Tibial Shaft Fractures in Adults: A Comparative Study

Rabi Narayan Dhar¹, Pradeep Kumar Merli²

¹Associate Professor, Department of Orthopedics, VIMSAR, Burla, Odisha, India

²Assistant Professor, Department of Orthopedics, VIMSAR, Burla, Odisha, India

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ABSTRACT

Background & Aim: Tibial diaphyseal fractures are the commonest long bone fractures in adults, most commonly managed by intramedullary interlocking nailing. However, several meta-analysis show that locking plate osteosynthesis is equally effective in managing tibialdiaphyseal fractures and are associated with less number of complications. Our aim was to compare the results of fixation of tibial fractures following plating and nailing in terms of union, patient satisfaction and complications. **Methods:** 100 patients with extra-articular distal tibia shaft fractures with a mean age of 38 years (range, 18-55 years) and mean Injury Severity Score of 13.5 were included in this study. Patients were randomized to a reamed intramedullary nail ($n = 50$) or a large fragment medial plate ($n = 50$). 80 fractures (80%) were open. 56 had concomitant fibula fractures that were stabilized. Outcomes like malunion, nonunion, infection, and secondary operations were measured. **Results:** In intramedullary group, average union time was 18.68 weeks compared to 21.15 weeks in plating group which was significant ($P < 0.0001$). Average time required for partial and full weight bearing in the nailing group was 6.65 weeks and 8.79 weeks respectively which was significantly less ($P < 0.0001$) as compared to 6.70 weeks and 12.22 weeks in the plating group. Lesser complications in terms of implant irritation, ankle stiffness, and infection, were seen in interlocking group as compared to plating group. Average functional outcome according to American Orthopedic Foot and Ankle Society score was measured which came out to be 95.88. **Conclusion:** Intramedullary group was associated with lesser duration of surgery, earlier weight bearing and union rate, lesser incidence of infection and implant irritation which makes it a preferable choice for fixation of extra-articular distal tibial fractures. However, larger randomized controlled trials are required for confirming the results

Keywords: Intramedullary, nailing, plating, tibia, fibula.

INTRODUCTION

Distal tibial fractures continue to be one of the most controversial fractures that we treat. The type of fractures include extra articular fractures of the metaphysis and the more severe intra-articular tibial plafond or pilon fractures. Fractures of distal tibia are also distinct from pilon fractures in mechanism of injury and also in the management. The mechanism of injury is bending force or twisting force that results in transverse, oblique or comminuted fractures resulting from high energy road traffic accidents when compared to pilon fractures which results from axial loading mechanism.^[1,2] Several treatment methods have been recommended for the treatment of these

injuries including variations of external fixation, intramedullary nailing (with and without reaming), and plate fixation with a recent emphasis on minimally invasive techniques. Studies of treatment outcome for distal tibial fractures of the metaphysis are uncommon. Locked intramedullary nailing is the TOC for closed fracture of tibial shaft.

Minimally invasive percutaneous plate osteosynthesis (MIPPO) was one such method in which plate was introduced percutaneously and fixed proximal and distal to the fracture percutaneously.^[3] MIPPO had advantage of biological fixation, less vascular damage, indirect reduction with less soft tissue stripping, proper restoration of axial and rotational alignment with sufficient stability to allow early range of motion (ROM) exercise and ambulation. But delayed healing, infection and hardware problems were some of the major concerns. It was technically simple, easier to master, need no additional expensive instruments, cheaper to the patient and facilitate early mobilization of the patients.^[4] A

Name & Address of Corresponding Author

Dr. Pradeep Kumar Merli,
Assistant Professor
Department of Orthopedics
VIMSAR, Burla, Odisha, India.

recent trend in internal fixation by MIPPO had been a move towards locking screws which can rigidly stabilize cancellous bone that is normally not amenable to screw fixation retaining the fundamental goal of treatment of distal tibial fractures as restoration of normal or near normal alignment and articular congruity. Locking compression plating (LCP) provides an angular stability for fixation. Locked screws prevent the plate from pressing the bone, preserving periosteal blood supply. This system stimulates callus formation due to flexible elastic fixation. The anatomic shape of the plate prevents malalignment of the fracture and provides a better axial and angular weight distribution. Our aim was to compare the functional outcomes of distal tibial metaphyseal fractures of tibia by anatomical locked plate by MIPPO technique to that with reamed intramedullary nailing, to alleviate the controversies regarding the complications arising from management of distal tibial metaphyseal fractures by nailing and plating by MIPPO technique and to set the indications for both modalities of fixation.

MATERIALS AND METHODS

All the patients were admitted to Orthopaedic Department of Veer Surendra Sai institute of medical science and research (VIMSAR)from November 2017 to October 2019.

The inclusion criteria:

1. Adults with age > 18 years and <55 years
2. Distal tibiaextraarticular fracture, minimum of 3cm of distal fragment.
3. Closed and Gustilo-Anderson grade I fracture
4. Patients who were medically fit for surgery

The exclusion criteria:

1. Displaced intra articular fractures
2. Gustilo-Anderson grade II and grade III fractures
3. Fracture with Neuro vascular injury
4. Pathological fractures
5. Fractures associated with compartment Syndrome
6. Patients who are medically unfit and not willing for surgery

Operative protocol:

Patients were operated under spinal anesthesia in supine position on a standard radiolucent table. Prophylactic intravenous antibiotics were administered 15 min before skin incision. An image intensifier was used in all the cases to provide fluoroscopic guidance. The patient was positioned supine with the hip flexed 45° and the knees flexed to 90° on radiolucent table. A 5-cm incision along the medial border of the patellar tendon was made, extending from the tibial tubercle in a proximal direction. The patellar tendon was retracted

laterally to expose the insertion site and protect the tendon during insertion. Then the awl is inserted where the anterior tibia reaches the joint. Utmost care is taken to stay in the extra-articular area because back of the nail may impinge on the femoral condyle. Nailing was done using standard technique and all fractures were fixed with two proximal and two distal locking screws.

In MIPO, the leg was prepared circumferentially from the toes to mid-thigh and draped free. A longitudinal incision of length 3–4 cm was made bone deep over the medial malleolus adequate enough to put screws in distal fragment. The saphenous nerve and vein were preserved and retracted anteriorly. Then an epiperiosteal space tunneling toward the diaphysis was made using the blunt tip of the plate. The reduction was achieved with manual traction and manipulation. Anatomically, precontoured plate was used and was positioned on anteromedial aspect of distal tibia by passing it through the subperiosteal tunnel. After insertion of plate and achieving the reduction, the plate was temporarily fixed to bone with K-wires and fixed proximal fragment with one locking screw. Distal fragment fixation was done with a combination of locking and cortical screws. Depending on fracture pattern and bone quality the decision of inserting the lag screw was made. Insertion of screws in the proximal fragment was done with small stab incisions.

Postoperative protocol:

Operated limb was immobilised in posterior splint. Mobilization of the knee and ankle was started in the immediate postoperative period. Early nonweight bearing mobilization of the patient was started from 5th day onwards after inspection of suture line. X-ray radiograph of the involved leg was taken post operatively, at 6 weekly intervals till union and at 1 year followup.Acceptable alignment was defined as less than 10° anterior/posterior angulation, less than 5° varus/valgus deformity or less than 10° rotation difference and shortening less than 1 cm.Malunion was measured by the angle created by the intersection of the subchondral line of the plafond and a line drawn up the centre of the tibial shaft. Ninety degrees was considered normal and deviations of more than 5° were recorded as either varus, valgus, more than 10 °anterior or posterior angulation. Rotational malalignment and limb length discrepancy was assessed clinically comparing with other limb (block method). Patient was discharged after suture removal with strict orders of non-weight bearing till next follow up. Patient was followed up clinically and radiologically at 6 weekly interval till union and at 1 year. A clinical evaluation for the functional assessment of the ankle was obtained at one year follow-up by Olerud and Molander Ankle Score

(OMAS) and The American Orthopaedic Foot and Ankle surgery (AOFAS) scoring. The OMAS is a patient reported score but is more specifically related to injuries around the ankle and includes assessment of: pain, stiffness, swelling, stair climbing, running, jumping, squatting, supports and work and activities of daily living. It is transformed to a 100 point scale, where 100 represents normal function and 0 the worst possible function. The American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale is a clinical rating system developed by Kitaoka et al. It combines subjective scores of pain and function provided by the patient with objective scores based on the surgeon's physical examination of the patient. The AOFAS clinical rating systems do not incorporate any radiographic criteria into the assessment. The patients rate his or her pain and function levels on a written questionnaire. Then we do the physical examination of the patient to assess the sagittal motion, the hind foot motion, the ankle-hind foot stability, and the alignment of the ankle-hind foot. The AOFAS Ankle-Hind foot Scale is scored with a possible 100 points. There are no defined limits of what scores constitute excellent, good or poor outcome. The final results at the end of 2 year follow up were evaluated using the "Johner & Wruhs' Criteria" as excellent, good, fair and poor.

RESULTS

In our study, 100 cases of extra articular distal tibia fractures were treated. All cases were fresh, 76 patients were male and 24 female. The mean age of patients was 37.6 years. Out of 100 fractures, 82 were caused by road traffic accident, 8 from fall and 10 had history of assault. 68 patients had fracture on left side and 32 on right side. All fractures were classified according to AO/OTA classification of which 26 fractures were 43A1, 58 fractures were 43A2 and 16 fractures were 43A3. 72 fractures were closed and 28 were compound. The soft tissue injury was graded according to Tscherne classification of which 8 fractures were type 0, 16 were type 1 and another 20 were of type 2 injury, 8 were type 3. All compound fractures were Gustilo-Anderson grade I type. All fractures in nail group united in this study and most of them united between 16-20 weeks. The mean union time was 18.68 weeks (95% confidence interval 18.712-20.817). All fractures in plate group except two united and most of them united between 16-24 weeks (95% confidence interval 18.987-22.551). 28 fractures in the nail group united between 21-24wks including 6 cases of dynamisation. Out of four fractures in mippo group which got deep infection, two cases finally turned to infected nonunion and treated with ring fixator after implant removal and infection control, which finally united at 46 weeks. The other two cases with discharging

sinus carefully followed-up every 2 weeks with proper antibiotic cover, finally they united at 27wks. In the immediate postoperative period radiographic evaluation of reduction and alignment was done, in which 36 fractures showed acceptable alignment, 4 fractures of nail group had valgus angulation of 8° and 2 fracture of mippo group had varus angulation of 10°. [Figure 1]

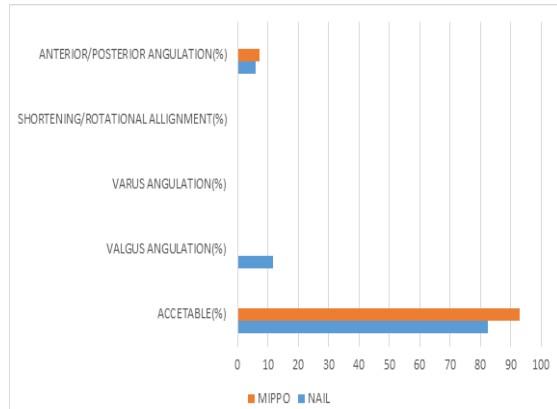
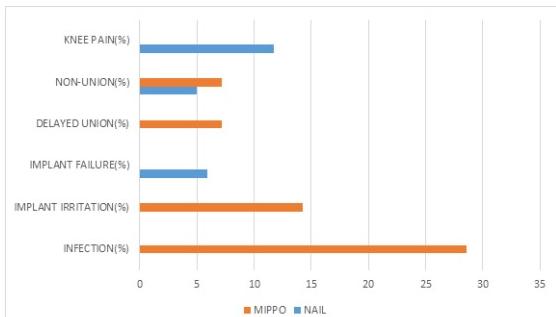


Figure 1: Alignment of Limb on Post op and Follow up Period

When followed up for one year the degree of alignment in all cases did not differ significantly and cases which were malaligned in immediate postoperative period went on to unite in that position except two cases in nail group which had good post-operative alignment developed recurvate deformity on subsequent follow-up and finally united with 15° anterior malalignment. None of the cases had rotational malunion and shortening. Infection occurred in eight cases all of which belong to the mippo group out of which 4 were superficial that controlled with dressing and antibiotic and caused no hinderance to bone union.^[4] other cases which developed deep infection, two of them were gone into delayed union but two other cases ended up with infected non-union. 4 cases of MIPPO had impingement and implant irritation for which symptomatic treatment was given. None of the cases which were treated with intramedullary nailing had infection as complication though 10 cases of our series were gustilo-anderson grade I. Two of the cases had implant failure in the form of breakage of distal locking screw in nail group, but it had no interference with fracture union. There were two cases of delayed union. Four of the cases of nail group had anterior knee pain that improved after nail removal. 8 cases required secondary procedures to achieve union. 6 cases were of intramedullary nailing group and all 6 were dynamised. The rest two cases were of mippo group that got infected and ring fixation was done to unite the fracture. [Figure 2]

**Figure 2: Complications Following the Procedures**

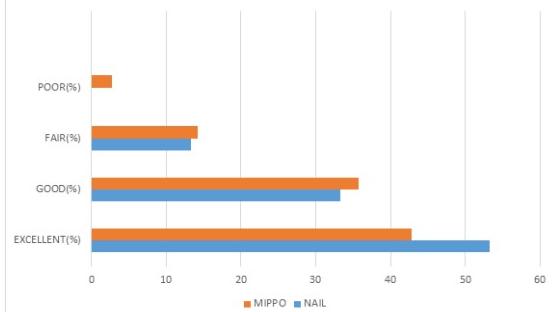
The minimum period of follow up in our study was 1 year ranging from 12 months to 18 months, except 4 cases which lost to followup after union of fracture. A clinical assessment of ankle function was done according to the criteria of Olerud and Molander Ankle Score (OMAS) and The American

Orthopaedic Foot and Ankle surgery (AOFAS) scoring. [Table2]

The mean OMAS for mippogroup were 97.143(range from 95 to 100), the 95% confidence interval being 94.685-99.601. The mean OMAS for nailing group were 99.333(range from 95 to 100), the 95% confidence interval being 98.385-99.316. The American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale is a clinical rating system developed by Kitaoka et al. It combines subjective scores of pain and function provided by the patient with objective scores based on the surgeon's physical examination of the patient. The mean AOFAS score for mippo group were 83.571(range from 78-89), 95% confidence interval being 81.881-85.262. The mean AOFAS score for nail group were 84.867 (range from 82-90), the 95% confidence interval being 83.579-86.155.

Table 1: Clinical assessment of ankle function.

Ankle Score	NAIL (n=50)		MIPPO(n=50)		
	No of cases	Percentage	No of cases	Percentage	
OLERAUD SCORE	100	46	92%	30	60%
	95	4	4%	10	20%
	90	0	0%	5	10%
	85	0	0%	5	10%
	<85	0	0%	0	0%
AOFAS SCORE	75-80	0	0%	15	30%
	81-85	40	80.00%	25	50%
	85-90	10	20.00%	10	20%
	>90	0	0%	0	0%

**Figure 3: Final Outcome Based On Johner and Wruhs Criteria**

The final outcome was assessed based on Johner and Wruhs criteria, 16 had excellent outcome, 10 had good outcome, 4 had fair outcome and 4 are lost to follow-up in nail group. Out of 28 of mippogroup 12 had excellent outcomes, 10 had good outcome, 4 had fair outcomes and 2 had poor outcome. [Figure 3]

DISCUSSION

Careful preoperative planning is needed in consideration with above mentioned factors in selecting the correct implant for given fracture pattern and associated soft tissue injury and minimizing the postoperative mal alignment and soft tissue complication.

Our study comprised of 68 patients with extrarticular distal tibia fracture out of which 34 were treated with intramedullary nailing and 28 with plate fixation using minimally invasive techniques based on soft tissue condition and fracture pattern. Decision of fixing the associated fibula fracture was done depending on initial displacement, intraoperative alignment of tibia fracture and whether it caused any disturbance to ankle mortise and syndesmotic stability.

In our study, we allowed weight bearing only after signs of union in form of bridging callus on at least 3 cortices on radiograph, absence of tenderness at fracture site and patient ability to bear weight is present usually by 12-14 weeks. We had 28 cases (82%) out of 34 in nail group and 20 cases (78%) out of 28 case in mippogroup, having fulfilling above criteria around 12-14 weeks and were allowed to bear weight. In study by Oh W, et al,^[5] on mippo the mean time for complete weight bearing was 13.2 weeks and it was 14 weeks in study by Mehmet et al.^[22] In study by M Aslam Siddiqui et al,^[21] on intramedullary nail the mean time for complete wt bearing was 13 wks and in similar study by Kasper W. Janssen et al, it was 14.2 weeks. Our findings are similar to these results.

All fractures in nail group united in our study and most of them (24 fractures) united between 16-20 weeks. The mean union time was 19.8 weeks (95%

confidence interval 18.712-20.817). 8 fractures in the nail group united between 21-24 weeks including 6 cases of dynamisation. In similar study by NorkS, et al,^[9] 80% of the fractures united before 30 weeks and the mean time for union was 23.5 weeks. Ehlinger M, et al,^[18] achieved union before 30 weeks in all cases, the mean time being 16 weeks. In study by Fan C, et al,^[8] had mean union time of 17.2 weeks. Robinson C,et al,^[3] 12 achived union in all cases by 22.2 weeks when treated with IMIL nail.

In MIPPO group,most fractures (18 fractures, 65%) united between 18-22wks,the mean being 20.8 weeks (95% confidence interval 18.987-22.551).2 cases in MIPPO group with delayed infection showed delayed union at 27 weeks.OhW,et al,^[5] in their study, similar to ours found the mean union time for these fractures treated with MIPPO was 15.2 weeks(range, 10-24weeks). In study by Ronga M, et al,^[16] union was achieved in all fractures by 24 weeks. In study by Borg T et al,^[7] they achieved union in 90% of fractures within 24 weeks. The mean time for union in CollingeC et al,^[12] study was 35 weeks but all fractures which were closed healed within 25 weeks.

Based on these findings we can conclude that dynamisation is an effective procedure and should be done in cases with slow progress to union before deciding on to more invasive procedure.In MIPPO group all fractures united without need of any secondary procedure except 2 cases that ended as infected nonunion and needed ring fixator for union. CollingeC et al,^[12] in their study had 8% cases requiring secondary procedures for union.In their study by J Guo, et al,^[19] all fractures in MIPPO group had united without any secondary procedure. Secondary procedure rate varies in different studies, 5% S.Hazarica, et al,^[10]2% (T W Lau et al)and 2.5 % in study by R K Gupta et al.All cases in our study treated with MIPPO healed without secondary procedures, this may be because of small number of cases in our study, all cases being closed and correct intraoperative techniques. In our study, we had acceptable alignment in 28 cases out of 34 (82.4%) in nail group and 26 cases out of 28(93%) in MIPPO group. Of 8 cases 6 cases which had malailgnment evident on immediate postoperative period healed in same position at follow up of 1 year and no significant change was noted.2 cases in nail group developedrecurvatum deformity on weight bearing and united with 15° anterior angulation. This finding suggests intraoperative error could the prime cause for malunion and it also throws light on difficulty in reducing the distal fragment accurately. 4 cases had valgus malunion and 2 cases had recurvatum deformity which were primarily fixed with IMIL nail and 2 had varusmalallignment which belonged to MIPPO.

In study by RongaM et al,^[16] 4 cases (21%) out of 21cases who were treated with MIPPO had unacceptable malunion with varus deformity and 2 had anterior angulation. None of the patients had rotational deformity and shortening. In study by CollingeCet al,^[12] 93% fractures united without significant malalignment..

In study by Ehlinger M, et al,^[18] on these fractures with IMIL nail, they had 27.5% of cases having malunion the most common being valgus or combination of valgus with other deformity in AP or rotational plane. In the study by NorkSet al,^[9] 3 out of 30 cases had malunion with one case in valgus and 2 cases recurevatum.JGuo et al in their study did not detect any case on malalignment.Study by A.Krishanet al,^[15] had malunion rate of 8% both in coronal and saggital axis. In above mentioned studies they did not had rotational deformity and shortening. It is evident that these fractures tend to malalign in valgus/varus or in anterior /posterior direction. Our results are comparable to above studies.

None of the fractures treated with nailing in our study had infection (superficial and deep) as complication though we had nailed 10 cases of Gustilo-Anderson grade I injuries.A.Krishan et al,^[15] in their study got only 2 cases of superficial infection though they had done nailing in 11 case including Gustilo-Anderson Grade I ,II and IIIA. In study by Ehlinger M, et al,^[18] they had 2 deep infections (5%) requiring lavage and in study by Nork S, et al,^[9] one case had deep infection. Guo J, et al,^[19] in their comparative study of IMIL nail with MIPPO concluded that wound complication are more with MIPPO than nailing (3% vs 6%).Our study also showed the same trend as above mentioned trend.

Four of our cases in nail group experienced knee pain, The cause for knee pain might be Proximal end of nail prominence above the cortex,that was subsided after nail removal.

None of the cases had implant failure as complication in our study except two where the distal locking bolt was broken. In these cases fracture united in due course but patient was lost to follow-up .In study by EhlingerM,et al,^[18] and in study by NorkS et al^[9] no complications related implant failure occurred. Oh W,et al,^[5] and A.Krishan et al,^[15] in their study had no implant failure cases. Where as M AslamSiddiqui,et al,^[21] had 2 cases of distal screw breakage. In MIPPO groupCollinge C et al,^[12] 38 had 7% cases having loss of fixation and S.Baharriet al,^[25] had implant failure fixation in 1 case. Where as Mehmet et al,^[22]D.Shrestha, et al,^[20] and Mohamed Sukeik,et al,^[17] found no implant failure in their studies on MIPPO.We had implant impingement and irritation in 4 of 28(14%) cases of MIPPO for which symptomatic treatment was given and patients are doing well. Oh W,et al,^[5] in their study had 40%

patients and D.Shrestha, et al,^[20] had 38% patients experiencing implant impingement. Lau T et al,^[14] in their study had 52% experiencing implant discomfort. Only 14% had their implant removed for this reason and opined that decision on implant removal for this complication should be justified. We opine that implant irritation and impingement is related to thickness of implant and designs, the better result in our study is due to use of low profile 3.5mm plate and better designed plate in our case series.

Oh Wet al,^[5] in their study on MIPPO had excellent to satisfactory results in all cases using olerud score at the end of mean followup of 20 months. Guo J et al,^[19] in their comparative study of IMIL nail with MIPPO had mean score of 83 for IMIL and 81 for MIPPO using AOFAS (American orthopaedic foot and ankle surgery) as scoring system for ankle function. According to this system, results will be graded as good if score is between 80-90. Collinge Cet al,^[12] in their study used both AOFAS (American orthopaedic foot and ankle surgery) and olerud score to evaluate functional outcome and had good results in most of their cases. So our study conclude that functional outcomes at one year follow-up does vary significantly between MIPPO or interlocking nail treated patients and it was in accordance with above mentioned studies. The final outcome was assessed based on Johner and Wruhs 24 criteria, 16 had excellent outcome, 10 had good outcome, 4 had fair outcome and 4 are lost to follow-up in nail group. Out of 28 of mippogroup 12 had excellent outcomes, 10 had good outcome, 4 had fair outcomes and 2 had poor outcome.

CONCLUSION

Both operative procedures have shown a reliable method of fixation and preserving most of the osseous vascularity, fracture hematoma which provide biological repair and can be used safely to treat distal metaphyseal fractures of the tibia (OTA Type 43A). In our study, IMLN group was associated with lesser duration of surgery, earlier weight bearing and union rate, lesser incidence of infection and implant irritation and failure which makes it a preferable choice for fixation of extra-articular distal tibial fractures.

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